

CLAIMS

1. An electrode-less discharge lamp lighting apparatus which is electrically connected to a dimming unit, comprising:

an electrode-less discharge lamp; and

5 a lighting circuit operable to apply a high-frequency voltage to the electrode-less discharge lamp,

wherein the lighting circuit includes:

an AC/DC converting unit operable to convert a phase-controlled AC voltage outputted from the dimming unit into
10 a DC voltage;

a DC/AC converting unit operable to convert the DC voltage into a high-frequency voltage and operable to intermittently drive the electrode-less discharge lamp by applying the high-frequency voltage to the electrode-less discharge lamp during a lighting-up
15 period of the electrode-less discharge lamp so that the electrode-less discharge lamp illuminates and by halting a generation of the high-frequency voltage during a lighting-out period of the electrode-less discharge lamp so that the electrode-less discharge lamp is extinguished; and

20 a dimming controlling unit operable to detect a timing of a turn-on of the phase-controlled AC voltage, wherein, based on the detected timing, the dimming controlling unit outputs an intermittent command signal to vary a ratio between the lighting-up and lighting-out periods and allows a current whose
25 value is at least a threshold to flow across output terminals of the AC/DC converting unit for at least a duration of a time lag between the turn-on of the phase-controlled AC voltage and the generation of the high-frequency voltage by the DC/AC converting unit.

30 2. The electrode-less discharge lamp lighting apparatus according to Claim 1,

wherein the dimming unit includes a switching element

operable to pass a current in both directions, and
the threshold is a value of a minimum current required for
the switching element to keep a turn-on state.

- 5 3. The electrode-less discharge lamp lighting apparatus
according to Claim 2,
wherein the switching element is a triac, and
the threshold is a value of a holding current of the triac.
- 10 4. The electrode-less discharge lamp lighting apparatus
according to Claim 1,
wherein the dimming controlling unit includes:
a timer circuit operable to output a signal indicating a period
of time that lasts at least the time lag; and
15 a switching element operable to allow a current whose value
is at least the threshold to flow across the output terminals of the
AC/DC converting unit via a resistor for the period of time indicated
by the signal inputted by the timer circuit.
- 20 5. The electrode-less discharge lamp lighting apparatus
according to Claim 4,
wherein the dimming controlling unit further includes:
a dimming control signal inputting circuit operable to output
a signal indicating the turn-on of the phase-controlled AC voltage;
25 and
a signal transmitting circuit operable to transmit the signal
outputted from the dimming control signal inputting circuit to the
timer circuit in a state where the signal transmitting circuit is
electrically isolated.
- 30 6. The electrode-less discharge lamp lighting apparatus
according to Claim 5,

wherein the timer circuit includes:

a capacitor;

a differentiating circuit operable to differentiate the signal transmitted by the signal transmitting circuit;

5 a switching element operable to allow the capacitor one of to be charged and to discharge in accordance with an output from the differentiating circuit; and

a comparator operable to compare an electric potential of the capacitor to a predetermined electric potential and output a
10 signal as a comparison result that indicates the period of time that lasts at least the time lag.

7. The electrode-less discharge lamp lighting apparatus according to Claim 1,

15 wherein the dimming controlling unit, when a dimming state set by the intermittent command signal is one of a full-state and a dimmed state, allows the current whose value is at least the threshold to flow across the output terminals of the AC/DC converting unit for at least the duration of the time lag between the
20 turn-on of the phase-controlled AC voltage and the generation of the high-frequency voltage by the DC/AC converting unit.

8. The electrode-less discharge lamp lighting apparatus according to Claim 1,

25 wherein the dimming controlling unit further includes:

a sawtoothed wave signal generating circuit operable to generate one of a sawtoothed wave signal and a triangular wave signal that is synchronized with the timing of the turn-on of the phase-controlled AC voltage;

30 a dimming command signal generating circuit operable to generate a dimming command signal that carries a voltage corresponding to a period of time during which the

phase-controlled AC voltage is turned on; and

a comparator operable to compare one of the sawtoothed wave signal and the triangular wave signal to the dimming command signal and output the intermittent command signal as a comparison result.

9. The electrode-less discharge lamp lighting apparatus according to Claim 8,

wherein the dimming controlling unit further includes:

a dimming control signal inputting circuit operable to output a signal indicating the turn-on of the phase-controlled AC voltage; and

a signal transmitting circuit operable to transmit the signal outputted from the dimming control signal inputting circuit to the sawtoothed wave signal generating circuit in a state where the signal transmitting circuit is electrically isolated.

10. The electrode-less discharge lamp lighting apparatus according to Claim 9,

wherein the sawtoothed wave signal generating circuit includes:

a capacitor;

a differentiating circuit operable to differentiate the signal transmitted by the signal transmitting circuit;

a switching element operable to allow the capacitor one of to be charged and to discharge in accordance with an output from the differentiating circuit; and

an outputting circuit operable to output an electric potential of the capacitor as one of the sawtoothed wave signal and the triangular wave signal.

11. A bulb-shaped electrode-less fluorescent lamp which is

electrically connected to a dimming unit, comprising:

an electrode-less fluorescent lamp;

a lighting circuit operable to apply a high-frequency voltage to the electrode-less fluorescent lamp; and

5 a base operable to electrically connect the dimming unit to the lighting circuit,

wherein the electrode-less fluorescent lamp, the lighting circuit, and the base are formed in one piece in a shape of a bulb, and

10 wherein the lighting circuit includes:

an AC/DC converting unit operable to convert a phase-controlled AC voltage outputted from the dimming unit via the base into a DC voltage;

15 a DC/AC converting unit operable to convert the DC voltage into a high-frequency voltage and operable to intermittently drive the electrode-less discharge lamp by applying the high-frequency voltage to the electrode-less fluorescent lamp during a lighting-up period of the electrode-less fluorescent lamp so that the electrode-less fluorescent lamp illuminates and by halting a
20 generation of the high-frequency voltage during a lighting-out period of the electrode-less fluorescent lamp so that the electrode-less fluorescent lamp is extinguished; and

a dimming controlling unit operable to detect a timing of a turn-on of the phase-controlled AC voltage, wherein, based on the
25 detected timing, the dimming controlling unit outputs an intermittent command signal to vary a ratio between the lighting-up and lighting-out periods and allows a current whose value is at least a threshold to flow across output terminals of the AC/DC converting unit for at least a duration of a time lag between
30 the turn-on of the phase-controlled AC voltage and the generation of the high-frequency voltage by the DC/AC converting unit.

12. The bulb-shaped electrode-less fluorescent lamp according to Claim 11,

wherein the electrode-less fluorescent lamp has a concave part, and

5 an induction coil to which the high-frequency voltage is applied is inserted into the concave part.

13. The bulb-shaped electrode-less fluorescent lamp according to Claim 12,

10 wherein the dimming unit includes a switching element operable to pass a current in both directions, and

the threshold is a value of a minimum current required for the switching element to keep a turn-on state.

15 14. The bulb-shaped electrode-less fluorescent lamp according to Claim 13,

wherein the switching element included in the dimming unit is a triac, and

the threshold is a value of a holding current of the triac.

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15. A discharge lamp lighting apparatus which is electrically connected to a dimming unit, comprising:

a discharge lamp; and

25 a lighting circuit operable to apply a high-frequency voltage to the discharge lamp,

wherein the lighting circuit includes:

an AC/DC converting unit operable to convert a phase-controlled AC voltage outputted from the dimming unit into a DC voltage;

30 a DC/AC converting unit operable to convert the DC voltage into a high-frequency voltage and operable to intermittently drive the discharge lamp by applying the high-frequency voltage to the

discharge lamp during a lighting-up period of the discharge lamp so that the discharge lamp illuminates and by halting a generation of the high-frequency voltage during a lighting-out period of the discharge lamp so that the discharge lamp is extinguished; and

- 5 a dimming controlling unit operable to detect a timing of a turn-on of the phase-controlled AC voltage, wherein, based on the detected timing, the dimming controlling unit outputs an intermittent command signal to vary a ratio between the lighting-up and lighting-out periods and allows a current whose
- 10 value is at least a threshold to flow across output terminals of the AC/DC converting unit for at least a duration of a time lag between the turn-on of the phase-controlled AC voltage and the generation of the high-frequency voltage by the DC/AC converting unit.

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